

EXAMPLE 11 The Growth in the Number of U.S. Internet Users

The bar graph in Figure 3.18 shows the number, in millions, of Internet users in the United States from 2000 through 2003. The function

$$f(x) = 34.1 \ln x + 117.7$$

models the number of U.S. Internet users, $f(x)$, in millions, x years after 1999. By which year will there be 200 million Internet users in the United States?

Solution We substitute 200 for $f(x)$ and solve for x , the number of years after 1999.

$$f(x) = 34.1 \ln x + 117.7$$

$$200 = 34.1 \ln x + 117.7$$

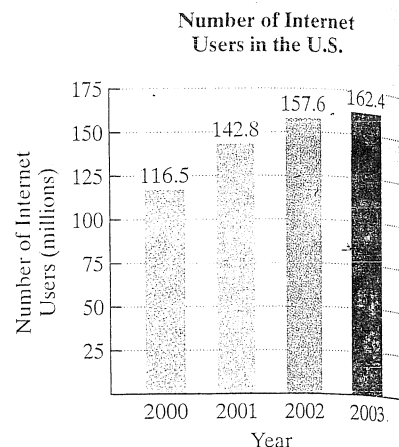


Figure 3.18

Source: Jupiter Media

Our goal is to isolate $\ln x$ in the equation $200 = 34.1 \ln x + 117.7$. We can then find x by using the definition of a logarithm to rewrite the equation in exponential form.

$$34.1 \ln x + 117.7 = 200$$

$$34.1 \ln x = 82.3$$

$$\ln x = \frac{82.3}{34.1}$$

$$\log_e x = \frac{82.3}{34.1}$$

$$e^{\frac{82.3}{34.1}} = x$$

$$11 \approx x$$

Approximately 11 years after 1999, in the year 2010, there will be 200 million Internet users in the United States.

Check Point 11 Use the function in Example 11 to find in which year there will be 210 million Internet users in the United States.

EXERCISE SET 3.4**Practice Exercises**

Solve each exponential equation in Exercises 1–22 by expressing each side as a power of the same base and then equating exponents.

1. $2^x = 64$

2. $3^x = 81$

3. $5^x = 125$

4. $5^x = 625$

5. $2^{2x-1} = 32$

6. $3^{2x+1} = 27$

7. $4^{2x-1} = 64$

8. $5^{3x-1} = 125$

9. $32^x = 8$

10. $4^x = 32$

11. $9^x = 27$

12. $125^x = 625$

13. $3^{1-x} = \frac{1}{27}$

14. $5^{2-x} = \frac{1}{125}$

15. $6^{\frac{x-3}{4}} = \sqrt{6}$

16. $7^{\frac{x-2}{6}} = \sqrt{7}$

17. $4^x = \frac{1}{\sqrt{2}}$

18. $9^x = \frac{1}{\sqrt[3]{3}}$

19. $8^{x+3} = 16^{x-1}$

20. $8^{1-x} = 4^{x+2}$

21. $e^{x+1} = \frac{1}{e}$

22. $e^{x+4} = \frac{1}{e^{2x}}$

Solve each exponential equation in Exercises 23–48. Express the solution set in terms of natural logarithms. Then use a calculator to obtain a decimal approximation, correct to two decimal places, for the solution.

23. $10^x = 3.91$

24. $10^x = 8.07$